



## **A global renewable energy system - A modelling exercise in ETSAP/TIAM**

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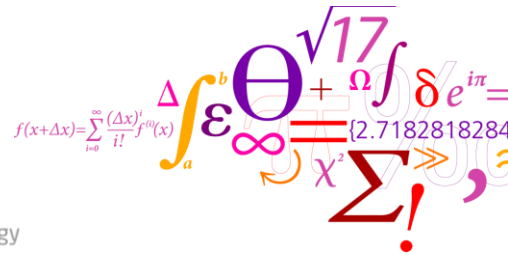
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# A global renewable energy system - A modelling exercise in ETSAP/TIAM

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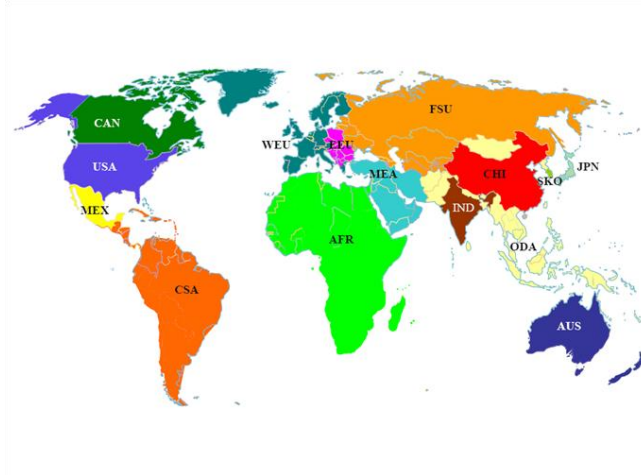


Risø DTU  
National Laboratory for Sustainable Energy

## Aim and background

- New group working with TIMES/TIAM
- Test the ETSAP-TIAM global energy system model
- How far it can take us towards a global 100 % renewable energy system with the existing model database?
- Where do we meet limits in global resources and data available in the model?

## TIAM – TIMES Integrated Assessment Model

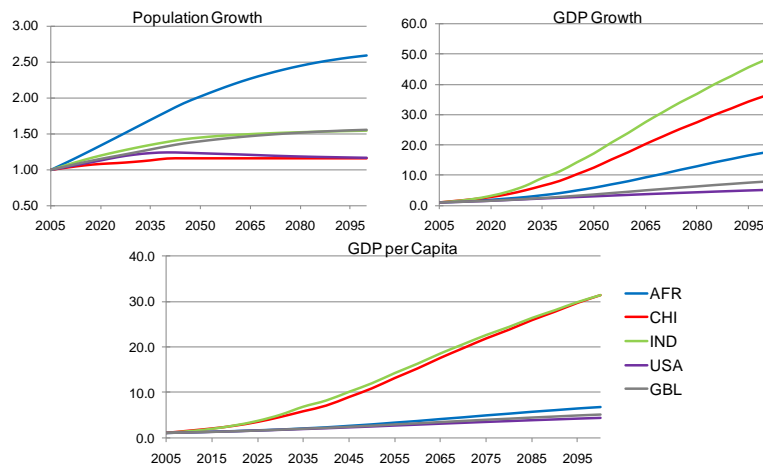


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## Growth assumptions (relative)

TIAM-15R, version September 2008

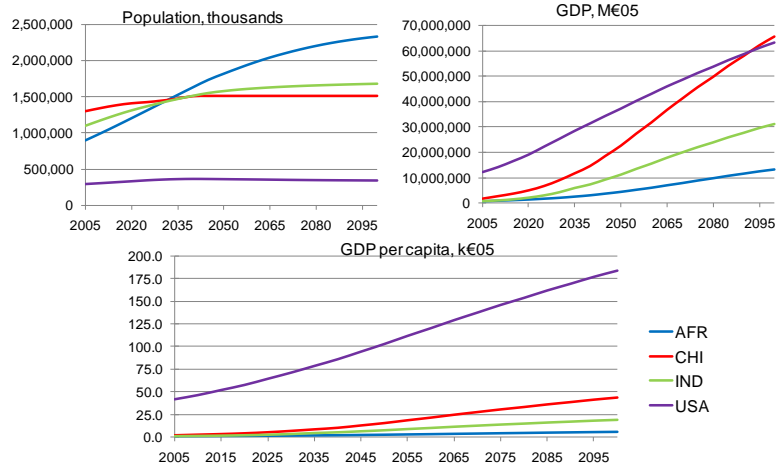


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## Growth assumptions (absolute)

TIAM-15R, version September 2008

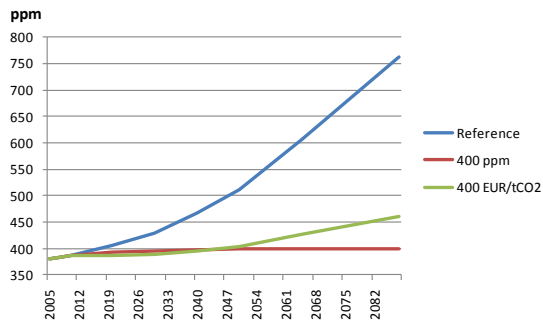


## Forcing renewables into the global energy system

### Scenarios:

- Reference scenario
  - Standard assumptions, policy-free
- Alternative scenario I: CO<sub>2</sub> ppm
  - CO<sub>2</sub> concentration in atmosphere restricted to 400 ppm
- Alternative scenario II: global CO<sub>2</sub>e price
  - The price for GHG emission fixed to 400 Euro per tonne CO<sub>2</sub>e

## CO<sub>2</sub> concentration and system costs

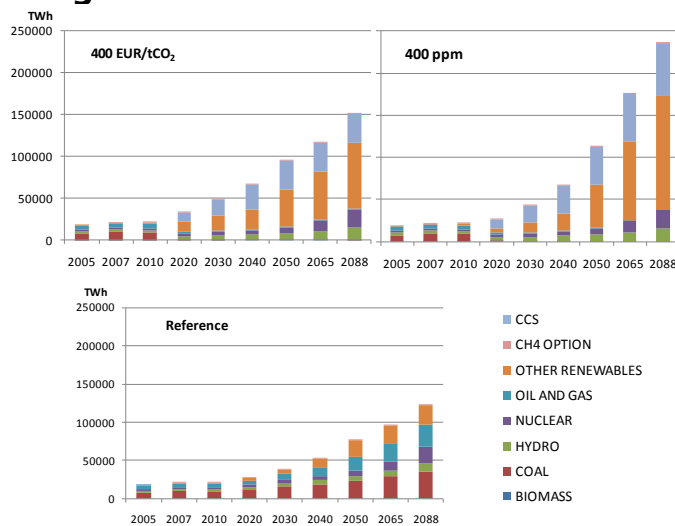


Scenarios	Costs above reference scenario (billion €)
400 ppm	38,955
400 EUR/tCO <sub>2</sub>	157,770

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## Power generation



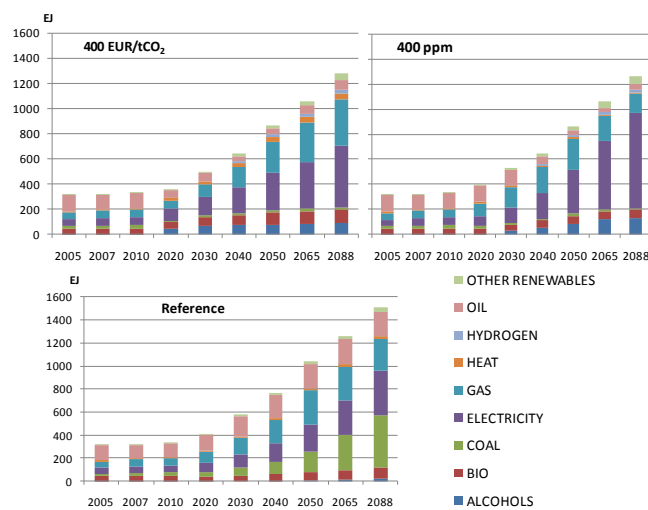
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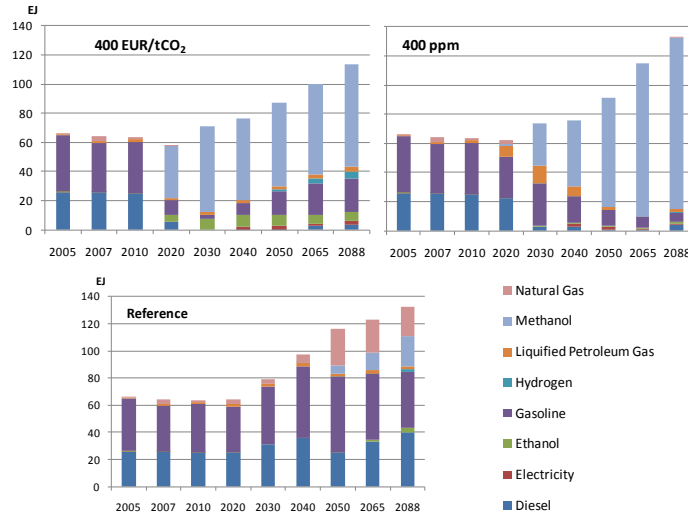
## Power generation (cont.)

- Large increase in power generation in alternative scenarios
  - Fuel switching in industry
  - Synergies between CCS and methanol – methanol penetrates in road transport

## Final energy consumption



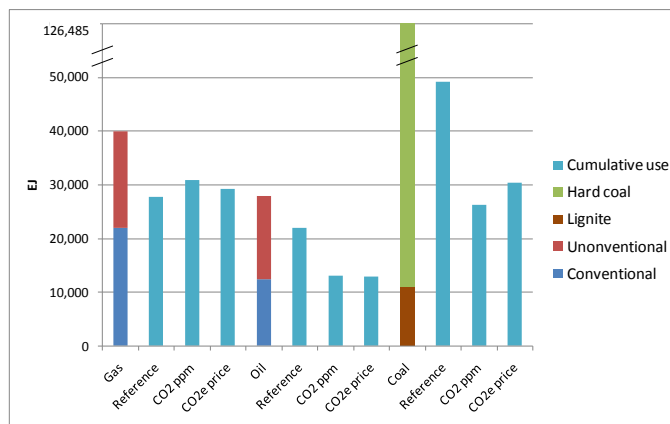
## Road transport energy demand



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## Fossil resources and cumulative use in 2100

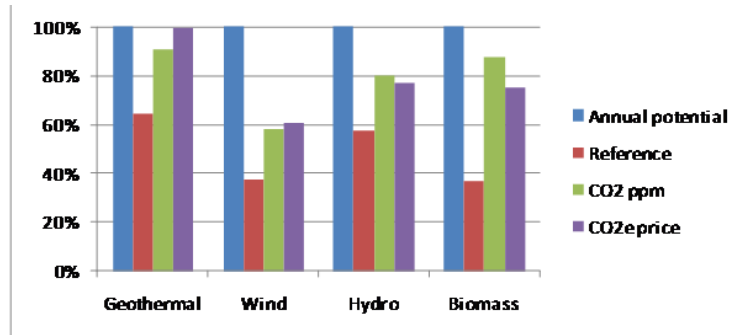


Source: "Review of resources and trade of fossil energy resources in the TIAM model" (ETSAP) and own calculations.

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## Renewable resource utilisation (2050)



## Conclusions

- A 100% renewable energy system was not achieved
- The system went (very) close to the resource limits
- Important to refine renewable resource potentials if a global 100% renewable energy system is sought
- Harder to reach a 100 % renewable system with the high economic growth scenario used in the current TIAM version
- Given the large efficiency potentials that exist now and in the future, energy efficiency is an important area where the databases for TIAM and thereby the investment possibilities for the model probably could be improved



## Discussion

- More detailed mapping of resource potentials will improve the model, including consideration of local conditions
  - Plan: to increase level of detail for renewable resources in the TIAM database for each of the 15 regions
  - Example: Wind power potential in Denmark and assumed production cost of 1 MWh electricity

Placement	Potential PJ/year	\$/MWh
Onshore	33	80
Offshore – near coast	144	90
Offshore – far from coast	1040	130

- Particularly problematic: biomass.
  - Complex link between biomass for energy, food and fodder
  - Varying yields
  - Improved database through detailed local studies

## The way forward...

- Internally financed project on renewable potentials and integration, with focus on India and China
- Applications:
  - InterAirPAC – Interaction of Air Pollution, Atmospheric Chemistry and Climate Change
    - TIAM for global scenarios
  - Development of an integrated framework and model system for health impact assessment of GHG reduction policies in urban areas of Europe and China
    - TIAM for global scenarios and policy analysis

# THANK YOU FOR YOUR ATTENTION!

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